

***Appendix D***  
***Brochure Titled “LNG Receiving Terminal”***  
***[see Section 2.2.1, 148.105(b)(1)]***

## LNG Receiving Terminals



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**Taking Gas and Power Further**



**Shell Gas & Power**

## INTRODUCTION - THE LNG VALUE CHAIN

**Liquefied Natural Gas (LNG) receiving terminals form a key component of an integrated gas supply chain from production through to customers. Shell is able to optimise the design of LNG receiving terminals based on a complete knowledge of how the rest of the chain functions.**



### Sodegaura LNG Receiving Terminal in Japan

Shell is the recognised world leader in LNG. Through its joint ventures, Shell is not only the largest seller of LNG but is also the Technical Adviser for many LNG facilities in operation or under development. This worldwide experience has been built up during decades of involvement in project development, operation, management and financing of large scale hydrocarbon infrastructure projects.

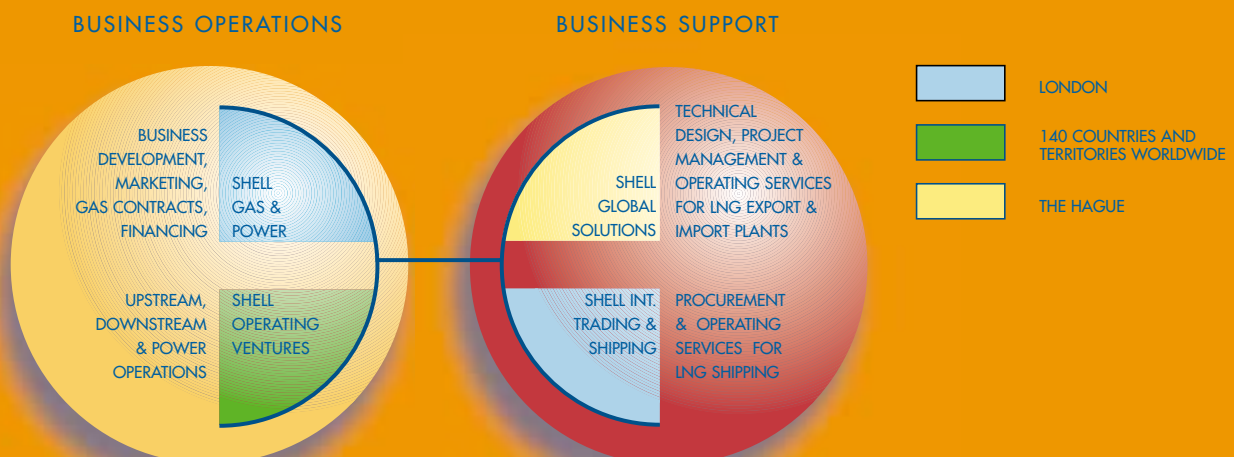
It places Shell in a unique position to offer truly integrated solutions bringing the best terminal design for the particular circumstances.

Shell can provide complete solutions for a conventional onshore receiving terminal. However, should the situation

require it, Shell's portfolio of LNG import options includes novel solutions such as small scale LNG import schemes, integrated terminal/power plant concepts, offshore floating and fixed structure concepts.

All of these solutions are geared towards addressing specific issues related to LNG import schemes, such as accommodating slow build-up rates, delivering gas and power at the lowest possible cost, reducing project lead times, overcoming environmental concerns, and maximising synergy with gas users.

Shell conducts its gas and power business in a structure that combines the multiple talents of its people in various fields, as illustrated in the figure below.



**SHELL'S EXPERIENCE IN LNG  
EXPORT AND IMPORT TERMINALS**

**Shell is applying its leadership in LNG technology with its commercial, financial and managerial strengths to develop new terminals and so bring the benefits of LNG to new markets.**

**BUILDING ON LONG-TERM EXPERIENCE...**

The most valuable single contributor to Shell's position as world leader in LNG sales and LNG technology is the continuous feedback of knowledge from research to risk assessment, design into construction and commissioning, and subsequently into operations and maintenance and back into research.

Shell is a world leader in the design and operation of LNG production plants. Many of the key elements of receiving terminals mirror the same elements of export terminals: shipping and marine conditions of the port; jetty and LNG unloading systems; cryogenic piping to the LNG storage tanks; LNG pumps and transfer systems; vapour recovery systems.

Shell was the technical adviser to the construction and start-up of the Zeebrugge receiving terminal in Belgium. This terminal includes import terminal, peak shaving and underground storage facilities, handling LNG deliveries primarily from Algeria. Gas is supplied both to Belgium directly, and via its gas transportation pipeline grid to other countries in Europe.

Shell delivers LNG to the majority of terminals around the world in Shell managed or operated LNG carriers, and has built up a close association with the terminal operators. Shell conducts a thorough safety and compatibility check of these terminals before Shell operated ships can discharge there.

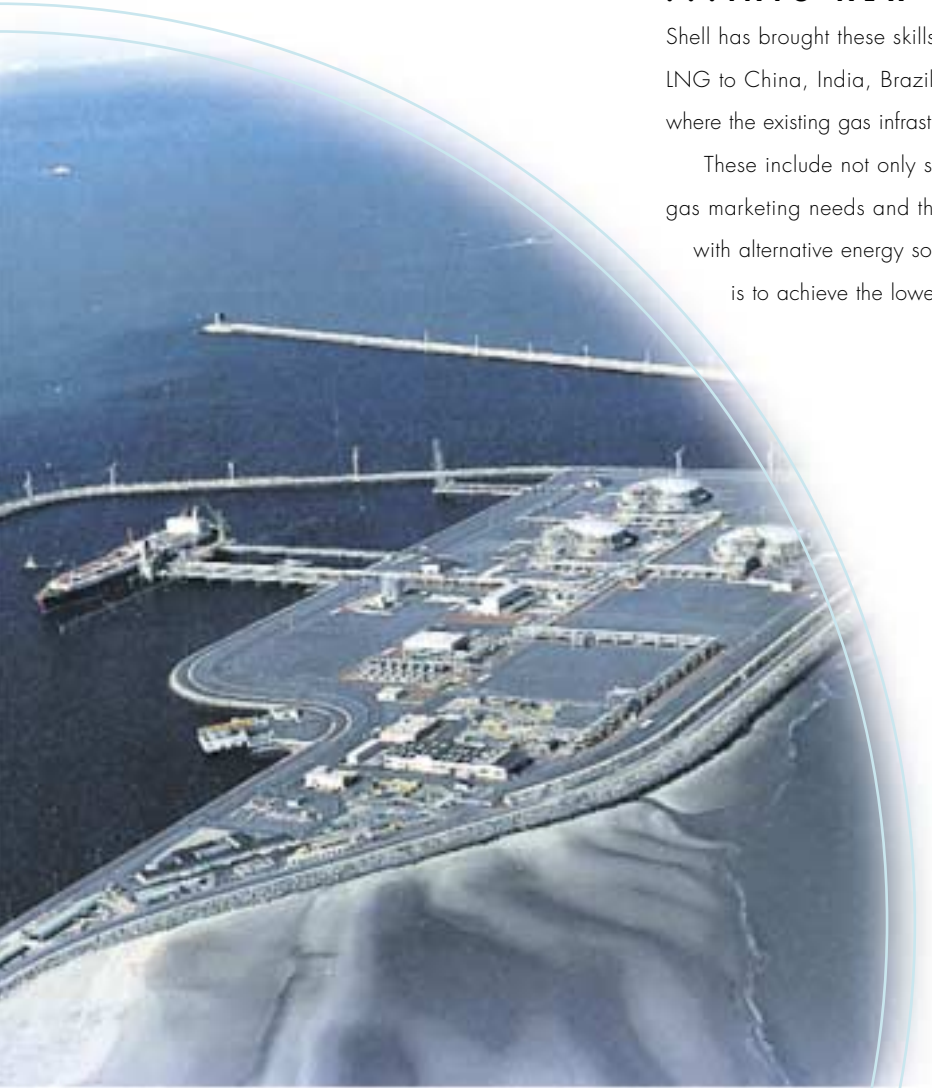


LNG terminal critical success factors

### **. . . INTO NEW EXPANDING MARKETS**

Shell has brought these skills to bear in its extensive efforts to promote the introduction of LNG to China, India, Brazil and the Mediterranean. Introducing LNG to a new market, where the existing gas infrastructure is minimal, provides a special set of challenges.

These include not only site location and technical aspects, but also LNG supply and gas marketing needs and the ability to present a viable economic proposal competitive with alternative energy sources matching local market conditions. The ultimate objective is to achieve the lowest gas or electricity cost at the point of sale.



Distrigaz's LNG terminal at Zeebrugge, Belgium

## TERMINAL CONCEPT DEVELOPMENT AND DESIGN

**Developing the optimal geographical location to meet market demand in consultation with the customer, and selecting the most suitable terminal concept, are the most critical steps in LNG receiving terminal design.**

### CONCEPT DEVELOPMENT AND SITE SELECTION

The most significant impact on cost for a new terminal is likely to be achieved through careful site and concept selection. This process can start right back at reviewing suitable locations over the entire coastline of a country, based on marine conditions and proximity to the markets for gas and power. Shell has conducted such master-plan studies for many potential LNG importers.

Location and market conditions can determine to a great extent the decision between an onshore and offshore terminal development. Once a general location has been selected, many factors must be considered during selection of the exact LNG terminal site, particularly if the terminal is being developed within an existing port.



LNG vessel mooring to load at the North West Shelf LNG Plant, Australia

## HARBOURS AND JETTIES

For harbours, coastal and hydraulic engineering, jetty structures and floating facilities,

Shell can prepare cost-effective designs and advise on operation and maintenance strategies for ports and port facilities for import of LNG.

Shell also conducts optimisation studies for existing LNG receiving terminals to maximise performance, reduce operating costs, or to support expansion studies.

## LNG STORAGE TANKS

Shell has set LNG industry standards in cryogenic storage and has extensive experience in the design, construction and operation of LNG storage tanks. Shell tank designs have been used by many competitors and contractors in their LNG projects.

## EXPANSION PROJECTS

The demand for LNG will normally grow substantially from the initial level. It is therefore vital to plan ahead

for this, for both the initial storage capacity, and future expansion possibilities for jetties, storage and vapourisation facilities. Shell can optimise the design choice and capacity to meet a terminal's current and future needs in order to maximise the viability of the LNG terminal.

## PEAK SHAVING

A peak shaving LNG terminal is essentially the same as an LNG import terminal with only one exception: the LNG tank is filled with pipeline gas through a treatment and liquefaction process rather than imported by an LNG carrier. The storage and send-out facilities are very similar to a standard LNG import terminal, and depend on the gas customers to be served.

Shell has the experience and the technology to design and build such a peak shaving facility, to provide their customers with gas.

A peak shaving facility can be designed to guarantee gas supply during moments of high peak demand such as cold winters. A peak shaving LNG facility could also serve as a back-up to a gas production and treatment facility, to guarantee gas supply to gas customers during planned and unplanned outage of production.



LNG storage tank at the LNG Plant, Brunei

MAXIMISING COST EFFECTIVENESS

With natural gas now the fuel of choice for environmentally friendly new power generation projects, the demand for LNG from new markets is expected to increase. Many of these new markets require relatively low volumes initially. Minimum cost is essential to support these countries in developing their LNG infrastructure.

LOW-COST TERMINALS

Shell cost forecasts for new, small-scale receiving terminals have reduced by up to 30% in recent years. This saving has been achieved through critical reviews of terminal design to reduce design margins to a minimum without compromising safety integrity. Significant cost savings have been achieved through:

- Critical site and concept selection during feasibility studies.
- Simplified marine facilities.
- Designs for increased LNG tank capacity for various tank concepts.
- Reduction and simplification in terminal equipment.
- Plant layout based on Quantitative Risk Assessment techniques.
- Optimisation of the LNG supply/storage send-out chain.
- Synergy and integration with gas fired power stations for LNG to power schemes.

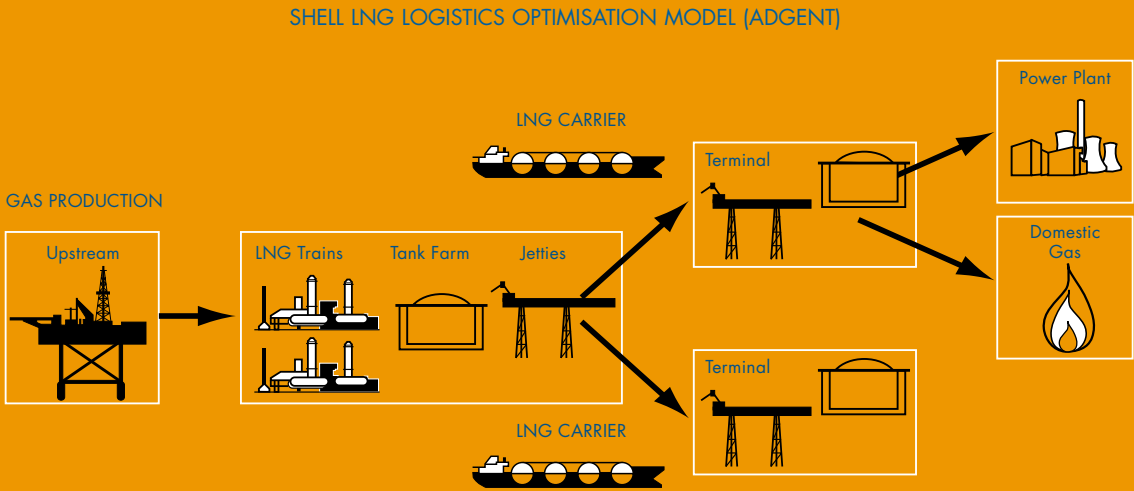
OPTIMISATION STUDIES

The main cost elements in a receiving terminal are usually harbour facilities such as jetties, breakwaters and dredged channels, and LNG storage tanks.

Detailed evaluation is needed to ensure that the port design, and volume of LNG storage, is sufficient to meet the supply requirement, without leading to excessive cost. Shell has developed a simulation model (ADGENT) to support these studies.



Example of Shell design for integrated terminal and power plant



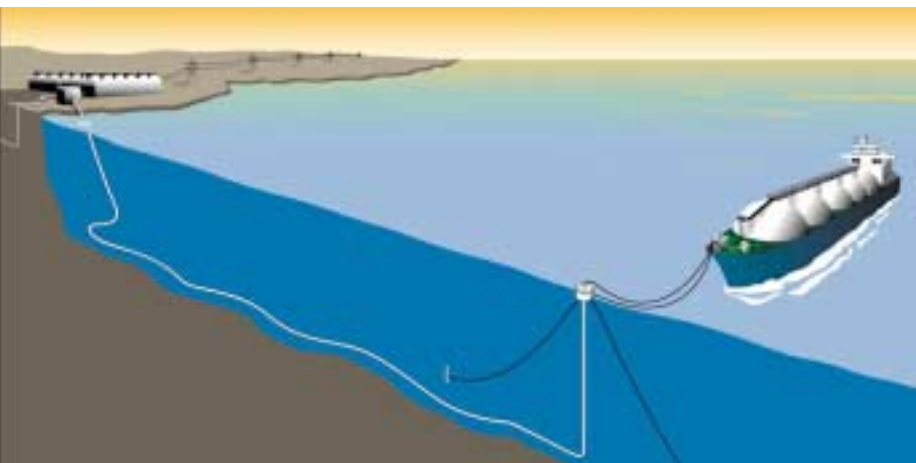
## EARLY GAS IMPORT SCHEMES

**Novel receiving terminal concepts, such as interruptible supply and on-board regasification, have the potential to open up new markets where the initial volume may not be sufficient to justify early investment for a dedicated and permanent onshore terminal.**

### INTERRUPTIBLE SUPPLY AND ON-BOARD REGASIFICATION

The floating terminal concept can be taken a step further by eliminating the purpose-built terminal altogether. The LNG shuttle tanker regasifies the LNG on-board, and sends gas directly to the customers via a gas single point mooring. Once the complete cargo of LNG is exhausted, the vessel disconnects and sails back to the LNG production plant.

A single vessel may be acceptable if the demand is very low, the LNG supplier is relatively close to the eventual gas user, and the customer can switch to alternative fuel whilst the LNG carrier is away.



On-board regasification for early or small-scale import

If a more reliable supply is needed, or for greater volumes, several vessels and two moorings can be used to guarantee a continuous supply.

This scheme is particularly attractive if there is a strong business case for early import. Shell has carried out detailed studies on this concept, and is in a position to offer it as a feasible solution for new, fast-track import projects.

## OFFSHORE TERMINALS

**Drawing on its upstream experience in offshore and floating production techniques, Shell has studied offshore LNG facilities since the early stages of the LNG business. Shell can develop solutions and can offer designs on the basis of floating or fixed offshore LNG receiving terminals.**

### ONSHORE VERSUS OFFSHORE

Offshore receiving terminals may be the preferred solution if any of the following conditions apply:

- No suitable onshore location is available at acceptable cost levels.
- Major dredging work or long distance jetties, or major breakwater facilities, would be required.
- Environmental issues or public opinion rule out an onshore facility.

An offshore terminal may be a converted LNG carrier, a purpose-built floating barge, or a gravity-base structure. Shell has the capabilities to advise on the evaluation and selection of these concepts to provide tailor-made solutions for our customers and partners.

### CONVERTED LNG CARRIER

The simplest design for an offshore facility is to convert an existing LNG carrier to allow LNG transfer from the shuttle tankers, regasification, and gas send-out. This solution will have a short lead time, but may introduce limitations on storage volume and may not be suitable for regions with severe weather patterns.

### PURPOSE-BUILT FLOATING TERMINAL

A floating barge eliminates the space constraints on LNG storage and regasification facilities that are imposed by a converted LNG carrier, and overcomes most of the possible disadvantages of an onshore development in case of long lead times or expensive marine developments.

### GRAVITY-BASE STRUCTURE

A gravity-base structure incorporates many of the benefits of the floating terminal concept, but is less sensitive to marine conditions and weather. This will improve the operational window and gas availability.

Shell can draw on many years of experience in LNG shipping and offshore operations to advise on which concept, and under what conditions, would be the most suitable for a given location on both technical and economic grounds. Shell has the skills in-house to develop such proposals, and to manage these projects from concept to implementation and operation.



Offshore LNG terminal on a gravity-base structure

EXPLANATORY NOTE

This brochure reviews the scope of the natural gas and power related businesses of the Royal Dutch/Shell Group of Companies (Shell). It describes the energy solutions that Shell offers to our customers, co-venturers and the communities with whom we work. Shell has five core business sectors, encompassing:

**Exploration and Production** searches for, finds and produces oil and gas. Builds the infrastructure needed to deliver hydrocarbons to market.

**Gas & Power** commercialises natural gas, supplies liquefied natural gas, develops markets and infrastructures, markets and trades natural gas and electricity, develops power plants and converts Gas to Liquids.

**Oil Products** sells and markets transportation fuels, lubricants and speciality products. Refines, supplies, trades and ships crude oil and petroleum products. Provides consultancy services to third parties based on Shell technology and experience gained in Shell operations.

**Chemicals** produces and sells base chemicals, petrochemical building blocks and polyolefins globally.

**Renewables** generates 'green' electricity and provides renewable energy solutions. Develops and operates wind farms, manufactures and markets solar systems and grows sustainably managed forests.

**Other activities** other business activities include: Shell Hydrogen, Shell Trading and Shell Consumer.

These business sections operate globally and are supported by Shell service companies in London and The Hague, and Shell's research laboratories. Shell's global presence, local knowledge and worldwide pool of expertise and skilled people are available to meet our customers' needs in gas and power.

SHELL'S  
BUSINESS  
PRINCIPLES

Shell Companies operate under a code of conduct called the Statement of General Business Principles. These principles govern the way we operate and provide, for our employees and for the outside world, an ethical framework which is both mandatory and transparent. This statement has been a public document for the last 20 years.

The Group publishes 'The Shell Report' which provides information on its economic, environmental and social performances set out against the Group's Business Principles.

